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Science, technology and innovation, and the potential of culture, for promoting sustainable development and achieving the Millennium Development Goals

Report of the Secretary-General

Summary

The present report provides an overview of the potential of science, technology, innovation and culture as tools for societies to achieve the Millennium Development Goals and pursue sustainable development. The report argues that overcoming twenty-first century challenges such as extreme poverty, inequality and environmental degradation will likely require drawing on a range of innovations from science, technology and culture in the public and private sectors. Drawing on the work of the United Nations system in relation to the theme, the report offers a full spectrum of recommendations for an enabling environment for science, technology, innovation and culture to flourish. At the national level, public commitment to science, technology and innovation is critical, as is cultural awareness and the acknowledgement that innovations and policies must be tailored to each context. At the regional and global levels — with support from the United Nations — multi-stakeholder dialogue, institutional reforms and expanded, deepened partnerships around science, technology, innovation and culture are essential to ensuring that the benefits of advances in these sectors are broadly shared.

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I. Introduction

1. Less than three years before the deadline for the achievement of the Millennium Development Goals, eradicating poverty and pursuing sustainable development remain formidable challenges. As we take stock of progress, learn from the experience of the past dozen years and design a post-2015 development agenda, it is becoming clear that science, technology, innovation and culture hold huge potential as tools and enablers to realize the goals of countries.

2. In addressing the above issues, the report denotes science as the creation of new knowledge; technology as the application of knowledge (i.e., cell phone); and innovation as the application of technology (i.e., mobile banking). In turn, culture is intended as a comprehensive set of features of a society or social group that includes its beliefs, value systems, traditions and lifestyle.

3. Science, technology, innovation and culture can significantly impact each of the three pillars of sustainable development — economic, social and environmental. Specifically, science, technology and innovation drive the dynamic transformation of economies through productivity growth, which influences economic growth. Science, technology and innovation also affect economic growth through the knowledge spill-overs they generate between countries, firms and industries. Moreover, it provides opportunities to "leapfrog" intermediate development stages.

4. In turn, higher incomes and employment reduce poverty and help people meet their basic needs, including food security, health and education. Over time economic growth fuelled by innovations in science and technology can increase social cohesion, stability and democratic governance. In some of the most successful emerging economies, economic growth in recent decades has led to a virtuous circle in which an expanding middle class began to insist on greater social, economic and political participation. Advances in education, science, technology and economic growth in these and similar economies are improving the prospects for peace and security.

5. Science, technology and innovation are also central elements for increasing energy efficiency, reducing waste, mitigating climate change and embarking on sustainable development pathways.

6. At the same time, culture enables the achievement of the Millennium Development Goals by promoting a human-centred approach tailored to local contexts, thus improving the effectiveness of sustainable development processes and outcomes.

7. Culture is also a powerful global economic engine that generates jobs and income. Cultural goods and services, which build on practices, materials and skills available within communities, often need low capital investment. Furthermore, the creative and cultural industries represent some of the most dynamic sectors in the global economy, with rapidly expanding growth in Africa and the Middle East in particular.

8. Cultural diversity has an important, yet often underestimated, role to play in tackling current ecological challenges. Culturally-based, local and indigenous knowledge and skills and endogenous know-how are core resources for coping with climate change, preventing biodiversity loss and ensuring environmental sustainability. Such knowledge and skills have direct impacts on job creation and

poverty reduction through cultural and heritage tourism sectors, and are integrated at various stages of the value chain of other sectors, particularly fashion and high-end industries.

9. In many cases, the failure of well-intended Millennium Development Goal initiatives can be attributed to limited understanding of contextual specificities that could alter the outcomes of development interventions. In the post-2015 era, strategies that are better attuned to varied cultural perspectives will increase the possibilities for local ownership, thereby improving the results and sustainability of development outcomes.

10. The current deliberations on the post-2015 agenda provide an opportunity to bring the potential of nationally tailored culture and science, technology and innovation policies to the table, including through the mobilization of local knowledge. Policies with clearly articulated goals and targets that are strategically linked to education, economic, industrial and environmental objectives can facilitate knowledge-based innovation and increase productivity.

11. In sum, science, technology, innovation and culture are critical to the achievement of the Millennium Development Goals and a successful transition to sustainable development. Consequently, science, technology, innovation and culture should be clearly articulated as enablers for sustainable development and important elements of the post-2015 development agenda.

12. The steadily increasing pace of technological innovation has made this an era of profound change, raising questions about how developments in science and technology can be used to minimize, rather than exacerbate, the gravest challenges today. As such, the potential return on investment in science, technology and innovation is high, especially in developing countries, which are relative latecomers — but increasingly contributors — to science and technology development.

13. Managing existing technology and non-technological innovation and cultural resources for sustainable development will require enabling legal, policy, financing and institutional frameworks at the national and international levels. This necessitates building capacities, in particular with the inclusion of women and youth, in the areas of knowledge, research and innovation, as well as the adaptation of appropriate developments in science, technology, innovation and culture in different contexts.

II. Global context for science, technology, innovation and culture

Open innovation

14. In recent years the world has witnessed a shift to more open, networked and collaborative models of innovation. In this new model — often referred to as "open innovation" — actors draw on multiple sources of knowledge, incorporating concepts from disparate disciplines to find innovative solutions to problems. In turn, this spurs robust development of knowledge-based societies in which innovative products and services are developed.

15. Studies suggest that, because knowledge is becoming more widely distributed, innovation increasingly needs to occur "at the interstices" of collaborating groups

and organizations, making networks important means for developing countries to exchange knowledge and advance their economic development. By working through an integrated and networked approach, multilateral stakeholders, national and local governments and private entities are better equipped to approach development processes in a more effective, inclusive and transparent way. Thus, networked innovation processes have advantages over more hierarchical forms of collaboration, including collectively managing the benefits and risks that accompany innovation processes.

16. Web-based technologies have also made new forms of science and technology collaboration possible. In particular, free and open-source collaborations and solutions have emerged, which enable a more inclusive and democratic approach to science, technology and innovation. These new forms of collaboration should be encouraged and expanded to include marginalized groups, such as women, girls and indigenous peoples.

17. Innovation systems have evolved into complex, cross-border collaborations with varied players and rules. The dynamics of this form of cooperation can be mutually beneficial and allow for specialization, or it can be biased and result in the branding of some countries as innovative while others are lagging. This often means that a country's position within innovation networks often influences the results of co-invention efforts and therefore requires countries to be more dynamic in networking activities and investing in research and innovation systems.

18. Open and networked models of innovation have also facilitated the use of knowledge produced mainly in developed economies by developing economies, where efforts to adapt solutions developed elsewhere to local contexts are becoming increasingly sophisticated. In some cases, this reduces the complexity of the original product, which then can be tweaked to better suit developing countries. In other cases, the innovation might "trickle up" to developing countries to be used in a manner not originally anticipated.

19. These innovation models place emphasis not on knowledge within an enterprise, but on untapped knowledge outside the enterprise, increasing the value of collaborative research on communication tools and newly developed networks of people. Such networks can be systemically organized or developed in an ad hoc manner among individuals who have the necessary expertise and knowledge. This, in turn, implies managing the fruits of that innovation, including through transferring knowledge to geographical regions that can benefit, creating policies and structures that encourage such innovation, protecting the innovative results through intellectual property and other mechanisms, and creating education and training programmes for those who will generate or commercialize the new products and services.

20. Innovation is rapidly changing in the manner in which it is carried out and where it occurs. Recent years have seen a significant shift in the geography of innovation with a new dynamic emerging. In particular, firms in middle-income countries, especially in East Asia, have seen a marked increase in their share of global research and development spending. Data on the top 1,000 global research and development spenders confirm that a number of multinationals from middle-income economies now conduct substantial research and development, on a par with multinationals of high-income countries.

21. However, persistent technological and innovation divides between countries and regions continue. The most important innovation gaps are between countries at different stages of development. On average, high-income countries outpace countries with lower per capita income by a wide margin in all innovation performance metrics. Around 70 per cent of research and development spending worldwide still takes place in high-income countries. Although middle- and low-income developing economies have increased their share of global research and development expenditure and patent applications, most of this increase is accounted for by East Asia. Gains have been more modest in other developing countries.

Internationalization of research and development

22. During the last two decades, research, development and demonstration stocks and flows have changed, illustrating a growing role for developing countries with technology-intensive policies and industries. Moreover, globalization and the connectivity and information provided by the Internet have influenced the way in which research is conducted and enhanced the speed with which collaboration can result in innovation.

23. Both public and private sectors are internationalizing their efforts in order to access and make use of globally dispersed knowledge, as well as connect with important innovation hubs in new markets. This approach involves universities and other research institutions attempting to attract and retain the best talent. Private companies also seek the most suitable innovation environment in which to locate or secure skilled personnel, supportive business conditions and market access. Governments can support such endeavours by linking national research and innovation systems, institutions and actors to global knowledge and innovation hubs. Creativity will be required to effectively engage universities, science parks and higher education institutions in monitoring and designing solutions that address local development priorities.

24. Strengthening research, development and innovation can promote economic growth and competitiveness, but one of the principal challenges is ensuring that the results of research and development infrastructure used by commercial entities for knowledge creation and innovation are directed towards sustainable development. Emphasis must also be put on the creation of centres of excellence in various disciplines, linked to key national and regional sectors that can, in turn, participate in technology transfer among innovative, medium-sized firms. In some developing countries, the major concern is establishing an innovation cycle suitable to the cultural context, with the option of shortening it to facilitate the smooth transition of knowledge to enterprise, with access to the research efforts of larger commercial entities.

25. Additionally, promoting the commercialization of research and development activity could result in the application of intellectual property rights to support new technology-oriented firms, rather than allowing open access to information and methodologies. One positive effect is that internationalization of research and development is associated with increased investment in high quality infrastructure for research and development, particularly at higher education institutions, which benefit students and also attract professional workers in research and development, contributing to building human capital.

Increased openness, transparency and participation in science, technology and innovation

26. Over the past decade, information and communications technology (ICT) innovation in particular has helped to foster a nascent open government movement based on transparency, accountability and participation. This has resulted in a wave of national freedom of information and data protection laws in many countries. The evolution of the Internet, including mobile and social networking technologies, has engendered more efficient, effective and responsive systems of public administration.

27. A recent trend in this area is the provision of open data by national and local governments. The push for open government data has arisen from the efforts of citizens seeking enhanced accountability and transparency through disclosure of data produced or collected by public institutions. While this development is grounded in a vision of more honest and effective government, the economic value of releasing public information assets for research and commercial use is increasingly becoming evident.

28. These initiatives, which often draw on and merge data sources from Governments, non-governmental organizations (NGOs) and private sector firms, have the potential to open up the entire process of innovation to a wide array of collaborators on stages ranging from the initial setting of research priorities to service delivery. More participatory approaches to the design and implementation of sustainable development policies can foster greater inclusion and buy-in, and more effective agreement on the pursuit of sustainability goals. Incorporating excluded groups — especially women and girls, youth, older persons, persons with disabilities and indigenous peoples — is especially important. This broadens the range of contributors to setting priorities and enhances the potential for success. These approaches, which in their most inclusive forms represent knowledge co-creation between scientific and local knowledge-holders, have proven to be powerful means of generating solutions to many problems.

III. Shaping the course of development: the role of science, technology and innovation

Integrating science, technology and innovation into sustainable development

29. Science, technology and innovation capacities are important prerequisites for structural and social transformation that enable economic growth, human development and poverty reduction. Critical to this are partnerships for strengthening the scientific and engineering capabilities of developing countries. These partnerships will need to be complemented by global and regional cooperation to foster research, product development, technology access, transfer and adaptation, which will be crucial for enabling transformative development.

30. As outlined in the report of the United Nations system Task Team on the Post-2015 United Nations Development Agenda entitled "Realizing the Future We Want for All" there are several ways to advance these proposals. Including in the post-2015 development agenda technology information networks and people-led innovation as critical resources for achieving sustainable development will help ensure progress on a range of twenty-first century development challenges, such as

in the areas of food and nutrition insecurity, environmental degradation and climate change.[1]

31. Technology-based solutions in these areas are already demonstrating their potential, for example, through delivery mechanisms for cheaper and more transparent social services in remote areas. In India, a portable machine produced in Bangalore that records a patient's electrocardiogram can be used in rural areas to diagnose heart disease.[2] Science, technology and innovation solutions that are already available will need to be promoted and scaled up within and across countries, particularly in disadvantaged areas or populations.

32. Innovation is a key driver behind economic growth and job creation. Green manufacturing can act as a catalyst for innovation and green job creation, as well as job retention, in the manufacturing sector and value chains, including services for energy efficiency and renewable energy, waste management and eco-product design. Furthermore, advances in modern technologies and communications have made a broad array of goods and services tradable and may offer developing countries ample opportunity for placing themselves at a comparative advantage for trade in the global services economy.

33. Advances in science and research can enhance the effectiveness of policymaking by providing evidence and inspiring innovation. As a result of the linkage between the two, innovation has come to be seen as a public investment, which is integral to ensuring that science, technology and innovation have an equalizing effect on society and are not limited to private gains or consumption. Therefore, Governments should promote rigorous science-based decision-making and application of scientific advancements for the benefit of society by enhancing the interface between science, policy and society, including establishing scientific advisory systems to support evidence-based decision-making processes.

34. National science, technology and innovation policies and systems will need to be designed within the context of national action plans for sustainable development. They must be strategically linked to education, macroeconomic and industrial policies, as well as other efforts to increase capacities for science, innovation and green technology development in developing countries.

Information and communications technologies

35. Information and communications technologies are the main gateways through which information and knowledge are accessed. They increasingly facilitate development by providing citizens with the tools necessary for self-empowerment and business with the avenues and know-how to significantly increase economic activity. In addition, the efforts of students and researchers to harness knowledge and information in order to actively contribute to development are made possible through open access to scientific information and open educational resources. Open access to scientific knowledge and the free flow of information should be expanded in order to bridge the knowledge gaps within and among societies.

36. Moreover, information and communications technologies are relevant to the post-2015 development agenda because they help Governments become better

[1] See www.un.org/millenniumgoals/pdf/Post_2015_UNTTreport.pdf.

[2] See S. Mani, *UNESCO Science Report 2010: The Current Status of Science around the World* (UNESCO 2010); available from http://unesdoc.unesco.org/images/0018/001899/189958e.pdf.

partners in the transition to sustainable development. Techniques such as e-participation, participatory budgeting, mobile voting, data mining and interaction through social media allow policy-makers to take the pulse of a constituency and reshape public services and policies in ways that more closely address the needs and aspirations of people. The application of information and communications technologies to extend and transform citizen engagement holds promise for sustainable development and for preventing and managing social unrest and conflict. The power of social media and cellular telephony both for mobilizing mass action and responding to it has been demonstrated recently in developed and developing countries alike.

37. Information and communications technologies in the public sector, if thoughtfully applied, can bring about massive improvements in efficiency. The public sector is primarily concerned with the use of technology to improve efficiency in service delivery. Such technologies enable government to become more adaptive in response to changing circumstances in complex situations. Policy-makers have also recognized the utility of mobile applications for service delivery, especially in hard-to-access areas or communities, including post-disaster or post-conflict environments. Making social transfers through mobile money is helpful in reaching low-income beneficiaries who live in remote or distant areas without access to banking services. In many ways, the widespread use of mobile devices in developing countries is changing what it means to be poor. For instance, in Haiti only 10 per cent of the population have bank accounts, while 80 per cent have mobile phones. The TchoTcho Mobile banking service became essential in the wake of the 2010 earthquake by giving Haitians the ability to pay securely for goods and services, as well as send and receive assistance in times of need. Farmers can keep track of their milking schedule through short message service and micro-entrepreneurs can access market information from remote locations, increasing the speed of trade and reducing travel costs. Similar approaches can impact positively on other sectors.

38. Technological innovation in government can also position the public sector as a driver of demand for information and communications technology infrastructure and applications in the broader economy. For example, studies to evaluate the impact of broadband on national economies have shown a direct impact on revenues and employment creation, as well as spill-over effects in other sectors by helping to increase efficiency and further stimulate broadband adoption. At the same time, information and communications technologies are known for a range of negative social and environmental effects, not least among which is the contribution to greenhouse gas emissions and environmental degradation. Governments should develop national infrastructure, governing structures and legal frameworks to harness the important potential of information and communications technologies for sustainable development, ensure its inclusiveness and minimize its negative consequences.

Sustainable agriculture and food security

39. The increasing prevalence of malnutrition in some regions is further evidence of the constrained capacity of many developing countries to meet the minimum nutritional requirements of their populations. According to the Food and Agriculture Organization of the United Nations, a 70 per cent increase in agricultural production will be needed by 2050 to keep up with population growth. This will exert enormous

pressure on the productive capacity of agricultural systems across the world and will have important consequences for farmers and consumers everywhere. Tackling this challenge requires serious rethinking of how food is produced, distributed and consumed globally.

40. Science, technology and innovation alone cannot provide all the solutions, but they are key ingredients of the policy mix to achieve food security through sustainable, equitable agricultural systems. Investing in sustainable agriculture is one of the most effective ways of addressing challenges to food security. Making the transition to sustainable agriculture will require significant use of innovation and new investment to protect and enhance the efficiency of natural resource use and to reduce waste at all stages of production, processing and consumption.

41. Innovations in biological sciences, resource management and agricultural processes will be essential to increase productivity and resource-use efficiency for sustainable agriculture, particularly in Africa. In order to achieve a "green revolution" in Africa, small-scale farmers — particularly women — should be given a central role in boosting food production and preserving the environment. Women manage 80 per cent of the continent's farmland and produce the bulk of its food. Many of them could double or even triple their currently low yields if provided the support needed.

42. The frequency of severe droughts and flooding globally implies that building resilience to climate change must become a central objective of agricultural research and innovation. The effects of climate change are already impacting the yields of staple crops such as wheat, rice and maize, endangering the very livelihoods of smallholder farmers. More climate-resistant varieties of crops, both new and traditional, would make them less vulnerable to rising temperatures and flooding. Innovation in crop and plant breeding is proving successful and will need to be scaled up. At the same time, more attention and support should be given to traditional agriculture, including methods of multi-cropping and maintaining high levels of genetic diversity.

Sustainable energy for all

43. Science, technology and innovation will play a central role in the promotion of sustainable energy. Access to energy creates economic opportunities and improves productivity, human health and education delivery, while narrowing socioeconomic inequalities. Public policy should be geared towards encouraging solutions that address the energy needs of households while protecting the health of families. According to the World Health Organization (WHO) and the United Nations Development Programme (UNDP), enhanced access to clean cooking technologies, especially for poor women, could lower household air pollution levels and greenhouse gas emissions and prevent nearly 2 million premature deaths each year from cardiovascular diseases and cancers associated with solid fuel use.

44. After a period of decline, publicly funded research and development on energy as a share of total public-sector research and development is starting to increase. With the changing models and locus of innovation, many developing economies are emerging as powerful investors in global research and development in energy technology. Public- and private-sector investment is approaching $20 billion

annually in these countries, which amounts to almost half of global investment in innovation in this sector.[3]

45. At the global level, two important steps have been taken to galvanize the international community on issues related to energy for sustainable development: the initiative of the Secretary-General for achieving sustainable energy for all by 2030, and General Assembly resolution 67/215 declaring the decade 2014–2024 the United Nations Decade of Sustainable Energy for All.

46. According to some recent estimates, universal access to electricity and clean cooking fuels and stoves can be achieved by 2030.[3] However, this would require moving away from a "business-as-usual" approach to embrace changes in business practices, innovation in financing, partnerships between the private and public sectors and the adoption and diffusion of already existing affordable technologies, such as solar energy or light-emitting diode (LED) lighting.[4] Innovative solutions will be essential to reach the 1.3 billion people without access to electricity and the 2.6 billion people in developing countries who rely on traditional biomass for cooking and heating.[5]

47. Innovative solutions, such as decentralized options that expand access to energy by underserved populations, can drive poverty reduction and job creation. In recent years, off-the-grid, decentralized energy options, which are often based on renewable energy sources such as solar, wind, hydropower or biofuels, have become more available. These energy options offer rural populations and other underserved communities new opportunities for accessing energy where conventional approaches have failed. Such options can create jobs if bridges are built between complementary energy and employment policies. Smart partnerships between the public and private sectors need to be leveraged so that clean and affordable energy is available even in the most remote areas, where business risk curtails the engagement of the private sector. Political leadership, appropriate priorities and long-term policies, coupled with a massive up-scaling of programmes, are also needed to enhance opportunities for investment.

Access to fresh water

48. The world recently celebrated the achievement of one of the targets of Millennium Development Goal 7 — halving the proportion of people worldwide without sustainable access to safe drinking water. This was an important milestone in the quest for water security worldwide. However, securing access to safe drinking water is only one aspect of water security. Between 70 and 75 per cent of fresh water is used for agriculture and the production of foodstuffs, not for drinking and cooking. Addressing challenges to clean freshwater access will require significant international cooperation, a strengthened science-policy interface and the development of institutional and human capacities around water conservation.

49. Climate change, urbanization and environmental degradation are threatening to put stress on freshwater sources, impacting negatively on human health, prosperity

[3] See International Institute for Applied Systems Analysis (IIASA), *Global Energy Assessment: Toward a Sustainable Future* (Cambridge, Cambridge University Press, 2012).

[4] Some of these solutions were proposed at the Annual Ministerial Review regional meeting for Asia and the Pacific, held in Bangkok, on 13 March 2013.

[5] See General Assembly resolution 65/151.

and security. In fact, around 80 per cent of the world population is exposed to high levels of water insecurity, in terms of availability, demand and hazards, among other factors. There is enough water available for our global future needs, but the world picture hides large areas of absolute water scarcity that affects billions of people, many of whom are poor and disadvantaged. Major changes in policy and management, across the entire agricultural production chain, are needed to ensure best use of available water resources in meeting growing demands for food and other agricultural products.

50. Technologies required for improving water quality and efficiency, such as through treatment and sewers, have existed for many years. Low-cost solutions will be needed in developing countries to augment access to water and improve water quality. These technologies will need to become more affordable, however, if they are to be adapted and diffused in developing countries. For that to happen, public investment will remain critical, as will partnerships with the private sector to ensure that water services reach even the most remote areas. At the same time, local innovation will continue to fill the gap. For example, in agriculture, locally driven solutions, such as micro-irrigation in India, help smallholder farmers increase their yields.

Climate change adaptation, mitigation and disaster risk reduction

51. As global climate change escalates, the risk of floods, droughts and severe storms increases. With 94 per cent of disaster-related deaths occurring in developing countries, the outlook for poor people is bleak. Climate change increases disaster risk in multiple ways. It changes the magnitude and frequency of storms and weather events, as well as impacting on average climatic conditions and climate variability. If climate change adaptation policies and measures are to be effective, they will need to incorporate standards for disaster risk reduction. Knowledge and science, technology and innovation capacities concerning global climate change and disaster risk reduction must be enhanced, particularly to fill gaps in understanding required by policy-makers to protect people, livelihoods and ecosystems. Actions should stimulate interdisciplinary and intersectoral partnerships, including the expansion of risk reduction and adaptation networks. Building the resilience of vulnerable communities, while reinforcing local response strategies rooted in traditional knowledge, is essential for climate change adaptation and disaster.

Leapfrogging makes sense

52. The rapid adoption of mobile phone technology in developing countries is indicative of a wider phenomenon. *UNESCO Science Report 2010* observed that "the old notion of a technological gap can today be considered a blessing for those economies possessing sufficient absorptive capacity and efficiency to enable them to exploit their 'advantage of relative backwardness'".[6]

53. This argument is reiterated by the Committee for Development Policy[7] in its annual report to the Economic and Social Council. Advances in technology could

[6] See H. Hollanders and L. Soete, "The growing role of knowledge in the global economy", *UNESCO Science Report 2010*, available from http://unesdoc.unesco.org/images/0018/001899/189958e.pdf.

[7] Committee for Development Policy, *Report on the fifteenth session (18-22 March 2013)*, Economic and Social Council, Official Records, 2013, forthcoming.

accelerate poverty reduction and sustainable development by opening up opportunities not previously available. For a developing economy, the key to expediting the transition to a sustainable development path is to "leapfrog" into the use of environmentally sustainable technologies while minimizing the use of fossil-fuelled technologies. This approach could facilitate technological catching up, and contribute to sustaining growth rates in the long term. Developing countries that are less locked into existing technologies and the infrastructure that supports them will be in the best position to leapfrog.[8]

54. In fact, leapfrogging is already a reality in some developing countries. According to a recent news article, Kenya's exports of technology-related services reached $360 million in 2010, up from $16 million in 2002.[9] The article stressed that start-ups in Silicon Savannah, as Nairobi is sometimes called, have designed products for mobile phones rather than for more expensive computers, which are less widespread: 74 per cent of Kenyans own a mobile phone.

IV. Potential of culture for sustainable development

55. Culture provides an entry point, as both an enabler and a driver, in virtually all sectors of sustainable development, encompassing the social dimension, economic development, environmental sustainability and peace and security. There is a growing awareness among both donor and beneficiary countries of the potential of culture for development, with investments allocated to culture in the framework of official development assistance. Priority is placed on initiatives focusing on legal frameworks, infrastructure, capacity-building, education and training in creativity and cultural fields, as well as culture-related human rights, such as the freedom of expression, and citizen participation. Greater emphasis on cultural contexts within development policies and programmes would enable a more effective, inclusive and human-centred approach to development. Governments should adopt at all levels a culture-sensitive approach to the formulation of social policies and the provision of public services, especially in the areas of education and health.

56. A growing wealth of research findings provides tangible evidence of the qualitative and quantitative contributions of culture to the various dimensions of sustainable development.[10] It is critical that a post-2015 framework integrate culture as a key element. Supporting evidence-based policymaking in the field of culture, and informing government policies on trade, industry practices, systems of incentives and the rights of creators should be part of this framework.

57. Different approaches can be used for incorporating culture into the post-2015 development agenda. Because it is inherently a cross-cutting issue, a culture-sensitive approach should be an overarching concern for all development initiatives. A reference to culture could be included, where appropriate, within an agreed sustainable development framework.

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[8] See also Committee for Development Policy, "Policy Note on Achieving Sustainable Development in an Age of Climate Change" (United Nations sales publication No. E.08.II.A.16).

[9] See *The Economist*, 25 August 2012, available from www.economist.com/node/21560912.

[10] UNESCO Culture for Development Indicator Suite, a pioneering research and advocacy initiative that aims to establish a set of indicators highlighting how culture contributes to development at the national level.

Culture for poverty reduction

58. The creative sector is a driver of inclusive economic and social development, adding value to economic activities relating to culture. The sector generates and exploits knowledge and information, triggering innovation. Cultural diversity and creativity, combined with scientific knowledge, can bolster nationally and internationally agreed development goals and contribute to economic growth and technological innovation.

59. This sector fosters human creativity and context-based development approaches that can deliver benefits well beyond the economic dimension. It contributes to an increase in capabilities and well-being by means of poverty reduction and the inclusion of women, ethnic minorities, youth and other marginalized groups.

60. The income produced by cultural industries globally in 2007 was estimated at $1.6 trillion. This points to a real opportunity for developing countries, especially since creative and cultural industries can be promoted with limited capital investment and have low entry barriers. Benefits flowing from this could stimulate trade and markets, contributing to debt alleviation and employment. For instance, cultural tourism accounts for 40 per cent of global tourism-related revenues and is one of the fastest-growing economic sectors, especially in developing countries. Cultural tourism accelerates investment in culture and creativity, revitalizing local economies and contributing to the preservation of diverse forms of heritage.

61. However, in many cases, creative and cultural sectors are characterized by self-employed artisans and small businesses, including women and other disadvantaged people who tend to remain in the informal economy. These groups need support in capacity-building, especially in linking to national and global markets.

62. Creative industries flourish where there is an appropriate regulatory framework and broad respect for culture and creative work within society. Intellectual property rights, guaranteeing the return of value to creators and enabling widespread access to content by the public, are fundamental to this framework. Such rights also generate income and employment, often with a direct impact on disadvantaged groups. Existing intellectual property rights, as well as sui generis rights based on intellectual property principles and systems, are important in protecting traditional knowledge from misappropriation and in equitably sharing benefits resulting from commercialization. Intellectual property systems should be tailored so as to promote technology dissemination and the protection of knowledge of indigenous and local communities.

63. Therefore, intellectual property rights are of fundamental importance to valuable cultural and economic assets of the indigenous and local communities who maintain, practice and develop them. In the era of the digital environment, greater emphasis needs to be placed on the exercise and management of rights, on the one hand, while, on the other hand, ensuring greater access to and sharing of creative works globally. Support through policy, law, copyright infrastructure, institutional collaboration and better business models is essential.

Education and culture

64. Culturally adapted educational programmes support and improve education through the promotion of intercultural understanding and the integration of disadvantaged and minority groups into the education system. The way people learn and transmit knowledge varies according to their different geographical, historical and linguistic backgrounds. Education strategies that are most responsive to local cultures, contexts and needs are therefore the most likely to be effective in fostering learning and more cohesive societies.

Culture and gender equality

65. The creative and cultural sectors provide opportunities for women to increase their capabilities and for employment and entrepreneurship. For instance, the participation of women in the crafts sector has been shown to strengthen women's economic opportunities, and improve their role in households and communities. As a result, empowerment through the creative and cultural sectors can have important implications for progress on issues as varied as enhanced household budget management and reductions in gender-based violence.

66. In advocating for the integration of culture within development policies and programmes, it should be clearly understood that "no one may invoke cultural diversity to infringe upon human rights guaranteed by international law, nor to limit their scope", as stated in the Universal Declaration on Cultural Diversity,[11] adopted by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 2001. Acknowledging and respecting cultural diversity, thus, should not be understood as a form of dividing communities, whether by gender, ethnicity or religion. Rather, respect for diversity should translate into informed understanding of the varied needs of individuals and communities, which, in turn, should impact on how policies to promote poverty reduction and inclusion can be effectively implemented.

Culture and environment

67. Many cultures regard nature as an extension of society, making culture-sensitive stewardship of the environment and natural heritage integral parts of sustainable development. The national, regional and international policies for the preservation and the revitalization of natural resources and cultural heritage have greatly contributed to preventing the loss of outstanding cultural and natural sites, cultural landscapes and historic urban and rural environments.[12]

68. With regard to the impact of culture on climate change adaptation and mitigation techniques, resilience to natural disasters has been shown to be enhanced through the use of locally specific techniques and construction materials, as well as community-based preparedness actions. Therefore, the reappraisal and consideration of local and indigenous knowledge systems and environmental management practices in preserving and managing natural resources are important components of

[11] Available from www2.ohchr.org/English.

[12] See the 1972 UNESCO Convention concerning the Protection of the World Cultural and Natural Heritage, with 190 Member States.

policies and programmes for climate change adaptation, mitigation and disaster risk reduction.[13]

V. Strengthening multi-stakeholder collaboration and partnerships

Strengthening science-policy-society interface

69. Although a wealth of scientific information is available on sustainability challenges such as climate change, dirty energy and water scarcity, this information often does not reach policymakers and other stakeholders in formats that are easy to understand or implement. The development of successful science, technology and innovation policies and strategies for sustainable development requires a continuous dialogue between scientists, policymakers and society. At the national level, a cross-sectoral approach is increasingly imperative for delivering coherent policies, joint services and integrated programme management in government. E-government initiatives can bring together key stakeholders across ministries and agencies for more effective problem-solving, strategizing and service delivery.

70. At the global level, the Intergovernmental Panel on Climate Change (IPCC) and Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services are some examples of efforts to strengthen the science-policy interface in the field of biodiversity and climate change, respectively. They bring together the scientific and policymaking communities in order to identify new scientific issues of importance to the policy community, and to ensure that research is dedicated to critical knowledge gaps for addressing sustainability challenges. More recently, the new scientific advisory board established by the Secretary-General aims to promote an improved interface between science and policy by, inter alia, providing advice to the Secretary-General and to the executive heads of United Nations organizations on science-related issues with regard to sustainable development. By virtue of its "thought leadership" role, knowledge base, coordination and integration mandates, the Economic and Social Council should be requested to develop concrete initiatives for strengthening the science-policy interface throughout its system.

Public-private partnerships for science, technology, innovation and culture

71. Public-private partnerships are a key policy tool for transitioning to sustainable development. They are fundamental to encouraging university-industry linkages that are critical to innovation and translating knowledge into enterprise. They can also be used to create networks of innovators and resources that inform and support decision-making. One clear area for technology transfer is in the application of information and communications technologies. Reliable information and communications infrastructure is essential for collaboration within and between countries, supporting research, health services delivery and connecting universities with higher education institutes. Governments should strengthen multi-stakeholder

[13] See *Traditional Knowledge in Policy and Practice: Approaches to Development and Human Well-Being*, editors, Suneetha M. Subramanian and Balakrishna Pisupati (United Nations University Press 2010), supported by the United Nations Environment Programme, which deals with different issues concerning traditional knowledge and resource management, including the role of traditional knowledge in water management.

collaboration and build partnerships for the creation of knowledge, technology and innovation for sustainable development, involving scientific bodies, the private sector, civil society, philanthropy and local governments.

72. Partnerships with local and vulnerable communities, including indigenous peoples and women, should also be enhanced in order to make science, technology and innovation more inclusive and accessible to all citizens. Such communities should be considered the final beneficiaries of innovation and the main actors of change. Measures should be developed for strengthening their capacities to access and absorb technological changes.

73. The culture sector has benefited from an increasing number of public-private partnerships in recent years, with especially successful experiences in the areas of cultural infrastructure, museums and urban development, along with the transfer of technology, building management capacity and the exchange of experience. Fruitful public-private partnerships in the culture sector have contributed to the optimization of resources and local development initiatives; attracted private investors and incubated ventures; and expanded opportunities for financial and social corporate responsibility. While the public sector puts in place systems that would support the management and exploitation of intellectual property assets, the private sector can contribute necessary resources to make cultural activities and products profitable.

VI. An enabling environment for transformative change towards sustainable development through science, technology, innovation and culture

74. The transformative change required for sustainable development cannot be achieved without an adequate enabling environment at all policymaking levels. Such an environment and associated incentive structures need to be framed within the concept of sustainability and its environmental, economic and social dimensions. In practice, policymakers are faced with formidable challenges in attempting to resolve trade-offs and build synergies for sustainable development owing to competing priorities and country conditions.

75. Furthermore, because many sustainable development challenges are global in nature, policy choices made in national contexts are not wholly isolated. Bottlenecks, disincentives and inconsistencies between the various policy levels abound and are difficult to remove, often a result of addressing other important development challenges. The policy space for decision-makers, especially in poorer countries, has become increasingly limited. Against this backdrop, a number of salient elements of an enabling environment are proposed.

A. National level

National science, technology and innovation strategy: culture of innovation

76. Several variables will impact the degree to which a national environment is successful at enabling science, technology and innovation development. Among these are differences in the level of economic development; the relative

contributions of the public and private sectors to the economy; and the levels of education and knowledge accumulation within societies, among others.

77. Although each national context is unique, many developing countries benefit from the experiences of others on how to adapt institutions and systems to promote capacities for innovation. In this regard, establishing the right mix of property rights, legal protections and public administration standards is essential. Equally important is the development of market institutions and systems that are supported by industrial policy, education and skills formation facilities and research institutions.

78. The demand for innovation and new technological solutions is as important as the supply. The high cost of existing technologies and other barriers, such as the lack of access to electricity, can limit their uptake. A suitable enabling environment, on the other hand, can stimulate demand for innovation.

79. Successful national science, technology and innovation strategies articulate a Government's vision of its role in development, set clear priorities for public expenditure and serve as a basis for engaging relevant actors. In some countries, the national science, technology and innovation strategy is part of an industrial development plan where sectors, rather than technologies, are prioritized. In these cases, prioritization of technology or sectors is often the result of cooperation between academia, the public and private sectors and international organizations, including United Nations system entities. If they are to be effective, national science, technology and innovation strategies should address the challenge of coordination among ministries and all other actors. Mechanisms typically used in this regard include coordination committees, joint policy councils and discussion forums.

80. Science, technology and innovation strategies tend to be most successful in contexts where the culture of innovation is encouraged to flourish. This is reflected, for example, in an appreciation of the importance of science, technology and innovation to well-being. It is also reflected in the social standing of innovators, scientists and engineers within a society. Added to this are less tangible ingredients, resulting in a culture of innovation: the practice of entrepreneurship; the tolerance of failure; creative thinking and intellectual curiosity; the ability to deal with fundamental uncertainties; and the willingness to question even basic beliefs. Governments can promote a culture of innovation through a variety of measures, including awareness campaigns that emphasize the potential of science, technology and innovation; increased visibility of the achievements of scientists and entrepreneurs within societies; encouragement of creativity and thoughtful risk-taking; science, technology and innovation-related campaigns targeting young people; and the nurturing of entrepreneurial skills within education systems.

Quality education to foster innovation

81. The development of effective science, technology and innovation systems is underpinned by national policies encouraging investment in quality science education at all academic levels, and specialized education, training and capacity-building in areas of emerging technologies and their applications. Sustained human and institutional capacity-building is a key building block for the development of powerful national science, technology and innovation systems, whether through

home-grown measures or international scientific cooperation.[14] Governments should develop and implement inclusive education policies to comprehensively address the wide range of challenges, from providing universal quality education for all to building entrepreneurial capacities; and from encouraging careers in the natural sciences and engineering to the creation of high quality doctoral programmes and life-long learning opportunities.

82. Governments should also promote policies and programmes that strengthen science education, in particular by encouraging science, technology, engineering and mathematics education of girls, career development of scientists and researchers and science, technology and innovation-driven entrepreneurial activities for young women and men. A range of measures can ensure greater participation by women and girls in science, technology, engineering and mathematics education. These include making science curricula relevant to their needs. Other strategies that have proven successful in different countries include promoting a positive image of careers in science and technology for women and girls; improving the retention and progression of women in science; ensuring that science, technology and innovation policies address the constraints faced by women entrepreneurs; and encouraging the use of gender-based analysis and gender impact assessments in research and development in science and technology. The growing popularity of massive open online courses and other open education resources also hold great potential to connect women and girls to science, technology, engineering and mathematics education.

Policies to foster research, development and demonstration

83. An active public research policy can bolster science, technology and innovation. The role of public research is to provide the basic research not usually funded privately because of the public good nature of the outcomes of the investigations and the examination of issues of national interest. Basic research is normally carried out at research universities and public research centres and is a precondition for applied research and engineering work. Securing a stable source of funding for public research — such as through institutional funding and grants — while ensuring that the highest standards of quality and relevance are reached, is imperative for building an active public research policy for science, technology and innovation.

84. Public-private partnerships for science, technology and innovation, where the coordination role of Government is recognized, have proven especially effective in fostering research, development and demonstration. In countries with weak research systems, Governments may undertake development cooperation initiatives with partners that can provide technical expertise and funding. These partnerships can support commercialization of research results through science and technology parks and incubators, technology transfer offices, expanded industry-university collaboration and collaborative research and development programmes.

85. Public funding and tax support for businesses developing new products and processes contributes significantly to strengthening science, technology and innovation. Firms, especially start-ups and small and medium-sized enterprises, face a number of barriers to obtain loans and other sources of capital for innovation.

[14] This issue was discussed extensively at the annual ministerial review regional meeting for Western Asia, held in Amman on 26 November 2012, on the theme "Science, technology and innovation for sustainable development".

These include asymmetric information between borrowers and lenders, lack of collateral, absence of a borrower's track record and resource limitations in firms' management capacities. Tax incentives for research and development can increase the profitability and thus the attractiveness of investing in innovation. Governments can also provide direct financial support to companies investing in innovation by subsidizing interest rates, providing guarantees to act as collateral or simply by supplying grants to be used as seed funding. Furthermore, policy should encourage and support the development of private forms of funding such as venture capital or business "angels", which are particularly suited to this style of funding and mentorship.

86. Another way to boost the attractiveness of innovation investment and improve the prospects for science, technology and innovation is through strengthening the role of the intellectual property regime. The innovation process involves a range of risky research activities that eventually generate information with public good characteristics. Unless individual firms can profit from this information, they will not undertake the necessary investments. Through the intellectual property regime, Governments can provide the incentives for firms and individuals to undertake creative and innovative activity by enabling them to obtain exclusive ownership of their findings for a period of time. In industry, patent and utility models protect inventions with industrial application, industrial designs protect novel designs, trade secrets protect confidential business information and trademarks protect the source of a good of one party from those of other parties.

87. The extent of protection and enforcement of intellectual property rights varied widely among countries around the world. The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS Agreement) in the World Trade Organization (WTO) attempted to narrow the gaps in the way these rights are protected within countries, and to bring them under common international rules. It established minimum standards for many forms of domestic intellectual property protection, such as copyright, patents and trademarks. Importantly, the Agreement included several "flexibilities" that can be used by developing countries in designing their own intellectual property regime system. In turn, the Agreement on Trade-Related Investment Measures (TRIMs Agreement) are rules that restrict preference of domestic firms and thereby enable international firms to operate more easily within foreign markets, by prohibiting practices such as local content requirements, manufacturing requirements and technology transfer requirements. Both agreements have considerable implications for permissible science, technology and innovation policies at the national level. There have been calls for a dialogue on intellectual property regimes and the possible evolution of their focus from protection of innovation to one that fosters its dissemination.

88. In WTO, within the Council for TRIPS and the Working Group on Transfer of Technology, there is also an ongoing debate over technology transfer and the patent system. It relates to the implementation of article 66.2 of the Agreement, which requires developed countries to provide incentives to entities located in their territories in order to promote and encourage the transfer of technology to the least developed countries. Current debates about technology transfer and the environment therefore raise the question of whether this amounts to another intellectual property and technology transfer debate, or whether environmentally sound technologies present distinctive challenges.

Good governance: accountability and transparency through open access

89. Accountable and transparent governance structures with clearly articulated national sustainable development goals must be in place to create an enabling environment for science, technology and innovation at the national level. National strategies for science, technology and innovation systems must not only describe roles, institutions and mechanisms for science, technology and innovation development, but should also be cross-sectoral and interdisciplinary in nature, linking knowledge systems to sectors such as industry, health, agriculture and energy. Action plans with defined goals, activities and timelines should be articulated so that Governments and citizens clearly understand how science, technology and innovation can contribute to their country's advancement.

90. Improving governance will require a greater understanding between policymakers, scientists and other science, technology and innovation stakeholders. Policymakers should understand better how science can contribute to their work, and scientists should better appreciate the challenges and trade-offs faced by policymakers. Scientific advisory systems to Governments and parliaments are essential in this respect, as well as national scientific assessments. Increasing the number of politicians with scientific backgrounds has been cited as a crucial factor in paving the way for science, technology and innovation to become more central to the preoccupations of Governments.

91. Effective science, technology and innovation systems are strengthened by good public understanding of, and engagement with, science. Open access to scientific information, through the use of information and communications technologies, is an important factor in developing scientific capacity in both developing and developed countries. In addition, through e-science, citizens are becoming important agents in the scientific endeavour, participating in the collection of scientific information and defining research agendas. Public and private investment in science museums and centres, and print and electronic media popularizing science, all contribute to building a culture of science in society. Governments should consider building capacities in science education and the popularization of science that engage citizens in science and research and reinforce the interrelation between science and society. In particular, Governments should ensure open access to publicly funded scientific research and public information assets.

Integration of culture into development

92. Although culture is recognized as a key component of sustainable development, this is rarely reflected in national budgets, especially in developing countries. The integration of culture into national development plans can lead to more dynamic cultural sectors, generating multiple benefits for society. Governments, notably in developing countries, should ensure that appropriate budget allocations are made to culture-related institutions and ministries, in accordance with national priorities.

93. The development of culture-related indicators and statistics will help evaluate its contribution to a number of development dimensions, thus strengthening advocacy for the integration of culture into future national development plans. It will also help analyse the potential of culture in national markets and address inequalities through studies and analyses.

94. Developing countries should be supported in their efforts to strengthen trade policy and national capacity development in order to expand the growing contribution of creative industries to international trade. This support could take the form of improved linkages with global and regional value chains, given the payoffs likely to occur for economic diversification and poverty alleviation and for participation in global innovation. Aid-for-trade regimes should recognize this need and act upon it, paying particular attention to women entrepreneurs and small and medium-sized enterprises.

95. Governments should implement national development strategies aimed at harnessing the potential of cultural industries for sustainable development through adequate regulation, facilitation of access to global and regional value chains and capacity-building, placing a particular emphasis on women entrepreneurs, marginalized groups and small and medium-sized enterprises.

B. International levels

96. Governments are increasingly pursuing regional science, technology and innovation policies that simultaneously support national and global actions. In particular, there are a number of regional agreements that specifically encourage scientific collaboration and the development and transfer of technology. These often include general provisions stressing cooperation in areas relevant to the development, the transfer and the adaptation of technology within a region, and specialized provisions establishing regional multinational enterprises. There are science, technology and innovation centres of excellences throughout the world, even in those regions that lag behind others on science, technology and innovation capacities. These centres of excellence should consider initiating productive partnerships to address sustainability challenges common to the region (for example, water security in Western Asia) and maintaining ties to international stakeholders where needed, while ensuring that problem-solving reflects regional, rather than external, priorities.

South-South cooperation

97. South-South cooperation is based on the premise that countries with similar socioeconomic conditions are able to share their experiences and support each other in development efforts. It allows developing countries to share knowledge, skills, expertise and resources through joint endeavours.

98. Impressive economic growth in a number of developing countries in recent decades has helped to pinpoint the important role of technological capabilities in the overall development trajectory. Following the successes of several East Asian countries, a newer wave of countries, such as Brazil, China, India and South Africa are now on a steady path towards industrial catch-up. This trend lends the hope that newer growth poles in the South could lead to new dynamics in international cooperation. The growth performance of these developing countries has led to a surge in South-South trade and investment, both of which carry the promise that these relations could be channelled to address specific developmental goals.

99. It is important to consider how and to what extent South-South cooperation could help developing countries overcome certain obstacles to economic expansion and achieve specific development goals. One such goal is to bridge the

technological divide so as to promote inclusive growth across the developing world. Going forward, the South will be an extremely important partner in all efforts to promote technology and innovation capacity in the developing world.

100. Governments should harness the benefits of South-South and triangular cooperation for sharing best practices on science, technology and innovation policies, transferring technology and knowledge and establishing regional innovation ecosystems. Data and information exchange, personnel and technology transfer are all important to building an enabling environment in science, technology and innovation in and between developing countries and countries in transition. Typical examples of cooperation activities include capacity-building programmes for scientific education and research; regional alliances among academia, Governments and industries; human resources development initiatives; joint research and training partnerships. These initiatives can be pursued by co-sponsoring the studies and research of young scientists, or joint programmes through partnerships with universities.

101. The potential for the application and diffusion of appropriate technologies from developed to developing countries is vast. The rise of innovative tailor-made, transferable and adaptable Southern solutions and technologies to address common challenges means that South-South cooperation has become an increasingly significant vector for the exchange of knowledge and technology. Improving access by developing countries to existing and new technologies, and promoting the development of their own technological capabilities remain important components of establishing balanced and equitable knowledge-based global markets. As part of the innovation ecosystem, the promotion of a balanced legal and administrative framework of intellectual property protection is also crucial to promoting and incentivizing innovation, investment and technology transfer.

102. The new and more collaborative models of innovation, as well as developmentally, focused South-South flows of finance, know-how and technology, should be further encouraged as an increasingly important dimension of development cooperation. In this regard, the role of developing countries as sources, and not simply recipients, of innovation should be emphasized. Scaling up South-South cooperation initiatives and facilitating inclusive partnerships among stakeholders both in the North and the South, will be increasingly important in optimizing the use of South-South and triangular approaches to inclusive and sustainable development.

103. South-South cooperation in culture fosters knowledge transfer and mutually beneficial economic and policy agreements. Some regional entities have successfully integrated culture into regional economic and policy debates and key policy frameworks and recommendations.[15] Such intraregional collaboration is beneficial for facilitating the circulation of cultural goods and professionals, as well as the development of market chains, and can also nurture a culture of peace by increasing networks.

[15] The Economic Community of Central Africa adopted a policy of integrating culture into its common strategic direction at the regional meeting in November 2012, held in Yaoundé.

Science, technology and innovation ecosystems

104. Technology progresses along a life cycle from research to development, and from demonstration to market formation and diffusion. Science is a necessary input for each of these stages. In the long run, there cannot be progress in technology without progress in science, and vice-versa. Similarly, science and technology adapt alongside society and its institutions, which ultimately determine the rate and shape of progress.

105. Significant gaps exist between technology stages across countries. One of the most critical of these is the commercialization gap. An effective technology innovation system is one that excels in each stage and seamlessly bridges the gaps between them. In such a system, capacity-building, finance and technology transfer play important roles in all stages. It should also be noted that technologies are typically composed of, or require inputs from, many other technologies; this requires infrastructure, education, technical capacities and a solid legal system.[16] Development cooperation at the regional and international levels can promote the creation of well functioning science, technology and innovation ecosystems by focusing on human capital development, and improved access to quality infrastructure, especially in the areas of transportation, water, information and communications technology and sustainable energy.

106. An enabling environment for knowledge generation and innovation requires three conditions to be met concurrently. First, goals are necessary to provide direction, but they have to allow for exploration of unexpected opportunities. Secondly, the ability to use outside knowledge ("absorptive capacity") is crucial to assess emerging scientific and technological developments and requires significant investment. Thirdly, the extent of outside communication, interaction and connectivity between innovation actors is vital to complex problem-solving, as it allows for specialization and diversity at the same time.

107. Taking into account the full technology cycle is essential in order to devise effective policies that "add up" to the sustainable development challenge. For example, government policies and programmes to support clean technologies have typically focused on the supply side and the diffusion stage. Yet, overall technological progress is driven mainly by demand with great potential in end-use and efficiency improvements.

108. More often than not, poorer countries aim to fill the gap in the early stages of the technology life cycle through government action, which, in many cases, becomes increasingly constrained by resource availability. Hence, improving the enabling environment needs to be based on a comprehensive view of the technology life cycle. Governments should consider the life cycle of technologies and implement policies and programmes promoting knowledge production, dissemination and utilization, and the development and appropriation of technologies within productive sectors.

[16] Potential entry points for development cooperation for the promotion of innovation were discussed at the annual ministerial review regional meeting for Europe, held in Geneva, on 10 April 2013.

Improving institutional coherence on science, technology and innovation and culture in the United Nations system

109. About one quarter of the global United Nations commitments on science and technology for sustainable development specifically address environmentally sound technologies. Commitments have typically followed a technology-centric perspective, which aims to facilitate technology transfer, in particular from developed to developing countries, for which it is considered crucial to raise financial resources and build capacity. There are a number of ongoing, high profile United Nations processes, all of which address some issues relevant to science and technology for sustainable development, including the follow-up to the United Nations Conference on Sustainable Development of 2011, the Fourth United Nations Conference on Least Developed Countries and the post-2015 development agenda.

110. A system of capacity-building mechanisms for technology and sustainable development has emerged within the United Nations system, although it remains fragmented. A survey of United Nations system activities[17] illustrates the range of capacity-building initiatives, which remain largely uncoordinated and ad hoc in terms of objective, content and country coverage. There is no global framework, agreement and assessment or monitoring mechanism for science, technology or culture for sustainable development. However, recent inter-agency cooperation and programming in culture and development projects have contributed to the development of living laboratories that can "Deliver as One", building on the comparative advantages of each agency, while promoting the integration of culture-related consideration and actions into the programmes of the different agencies.

111. The global research, development and demonstration network of clean technology cooperation has become almost universal, whereas in the past it involved essentially only developed countries. Currently, entities in 182 Member States participate in some form of international clean technology cooperation, with potential knowledge flows among all of these. However, the structures of technology cooperation networks differ greatly between technology clusters, reflecting national policy priorities, resource endowments and political considerations. Stronger scientific collaboration is needed among nations, including through joint research programmes that will seek scientific-technological solutions to global challenges.

112. One way of supporting coherence within the United Nations system is to consider technology goals for inclusion in future development goals, such as the sustainable development goals. The Secretary-General, in his report on options for a facilitation mechanism that promotes the development, transfer and dissemination of clean and environmentally sound technology (A/67/348) outlined a potential direction for technology goals that would be geared to ensuring that efforts "add-up" at the global level; equity would be prioritized; and institutions are prepared for the challenge. In particular, the report suggested various technology targets under three goals: to quadruple global technology performance; to provide universal access to sustainable technology; and to build a global green innovation system for sustainable development. Such goals should be supported by a science, technology

[17] See Department of Economic and Social Affairs and United Nations Industrial Development Organization, "Technology Development and Transfer for Climate Change: A Survey of Activities by United Nations System Organizations" (working paper, 2010).

and innovation strategy and action plan, for which developing countries will require support.

113. The same report also highlighted the "need for a technology mechanism that can accelerate technology progress on a global scale and that is commensurate with the sustainable development challenge". A technology facilitation mechanism could suggest overall technology-related sustainable development goals and promote four types of global and regional networks (initially based on existing institutions): networks of science foundations; business incubators; policy, intellectual property and organizations that aim to reduce and share risk; and technology transfer mechanisms and related instruments.

114. Regarding frameworks for culture at the global level, the outcome document of the 2005 World Summit acknowledged the diversity of the world and recognized that all cultures contribute to the enrichment of humankind. This, and related documents, including the outcome document of the United Nations Conference on Sustainable Development, call for the mainstreaming of culture into development policies and strategies, both as an enabler and driver of development. The United Nations system could integrate culture into United Nations Development Assistance Frameworks in order to take into consideration culturally sensitive approaches and culture-related programmes.

115. Culture-related international conventions safeguard cultural and natural heritage, intangible aspects of culture, the flourishing of creative and cultural industries and the protection of cultural property worldwide. The conventions support sustainable economic development, strengthen national identity and respect for diversity, and facilitate cultural continuity between generations. The ratification of culture-related conventions is also an important benchmark, as this can accelerate global cooperation in the field of culture by promoting technical assistance, collaboration, and standard-setting, safeguarding cultural and natural heritage, the flourishing of creativity and protecting cultural property worldwide.

Labour mobility and knowledge transfer

116. The mobility of human resources and their capacities, both domestically and internationally, among firms and through labour migration is an important mechanism for the promotion and further dissemination of science, technology and innovation. International mobility contributes to the adoption of best practices, greater openness and creativity, and the advancement of research and science. Governments and the international community can facilitate mobility by reducing regulatory barriers, encouraging mobility between universities and the business sector and easing the transition from higher education to employment. Policies can focus on bridging the demand and supply for technical skills. Governments could also implement programmes to attract highly trained students and researchers, as well as "diaspora" nationals in science and technology fields.

International technology transfer

117. International technology transfer encompasses cross-border movement of knowledge either embodied in goods, services, people and organizational arrangements or codified in blueprints, and designs technical documents and the contents of training programmes. It encourages learning and innovation through design and engineering knowledge. Benefitting from this, however, is not

straightforward; it is part of a learning process involving continuous exchanges between suppliers and receivers of technology and other stakeholders. Mastering a technology requires significant effort and time. Technologies need to be adapted to local conditions and necessitate the transfer of "tacit knowledge", which cannot be found in documents or manuals.

118. In the past 20 years, patterns of technology flows and transfers have changed significantly. A number of developing countries have gained prominence, but poorer and smaller economies have become increasingly marginalized. South-South clean technology transfer has become increasingly important, despite the persistence of barriers. International collective action eases the acquisition of foreign technologies through a range of policies, regulations and international treaties. Governments may consider mechanisms to target and/or regulate the level, the type, the quality and the timing of foreign technology acquisitions.

119. Technology is increasingly embedded in global trade and foreign direct investment flows, thus forming part of international production systems. Foreign direct investment is becoming increasingly used as a way to diffuse advanced technologies into a domestic economy. Ensuring that the benefits of these types of transfers are maximized requires supporting policies and initiatives, including information-sharing about equipment purchase or licensing abroad; offering training and capacity-building in relation to the acquisition of foreign technologies; and supporting technology transfer-related research and development. Furthermore, smart comprehensive national strategies are needed, aimed at attracting foreign direct investment, which promotes broad-based growth and enables national business partners, especially small and medium-sized enterprises, to move up the export value chain.

120. Arguably, industry structures, the nature of knowledge and intellectual property rights facilitate the development of technology markets. These markets influence the use and demand for knowledge, performance of the private sector, the division of labour and eventually economic growth. Market conditions indicate the importance of intellectual property rights for the promotion of technology transfer and dissemination. While the market model may be viewed as a route with plural advice and involving multiple players, regulators and promoters, encouraging competition, it might also be argued that it stifles open innovation and encourages the commercialization of knowledge.

Measuring capacity for innovation

121. Measuring innovation is a moving target. The definition of innovation has broadened; it is no longer restricted to research and development laboratories and published scientific papers, but also includes social business models and innovations.[18] The World Intellectual Property Organization-INSEAD Global Innovation Index helps to create an environment in which innovation factors are under continual evaluation, and it provides a key tool and database of detailed metrics for refining innovation policies. While the end results take the shape of several rankings, the Global Innovation Index aims to improve understanding of the levers of innovation and identification of targeted policies and good practices.

[18] The emphasis on innovation outside of science and technology as an undervalued resource for development was a key message of the 2013 annual ministerial review e-discussion jointly organized by UNDP, UNESCO and the Department of Economic and Social Affairs, held from 11 February to 15 March 2013.

Metrics and robust baselines are required to monitor and assess innovation and related policy performance in order to support the global debate, guide policies and highlight good practices.

122. The public sector has special responsibility for monitoring the risks and the challenges pertaining to science, technology and innovation policies and strategies. For example, uneven access to technologies, such as broadband Internet, is an area of concern for policymakers because it limits opportunities and can exacerbate inequalities.[19] Other examples within science, technology and innovation policies that need the specific attention of the public sector include cyber-security threats and cyber warfare; transboundary data protection; guarantees on the respect for freedom of information as a fundamental right; and monitoring of the private monopolization of science, technology and innovation sectors.

VII. Towards coherent policy and action frameworks: the Economic and Social Council as a "thought leader"

123. Given the rapid pace of change in the areas of science, technology, innovation and culture, there is a need for effective intergovernmental arrangements for maximizing their impact on complex, interrelated global challenges. As recognized by world leaders at the United Nations Conference on Sustainable Development, held in Rio de Janeiro, the Economic and Social Council system has a role to play in ensuring balanced and coherent integration of sustainable development.

124. The interrelated challenges of sustainable development and poverty eradication are at the heart of the mandate of the Economic and Social Council. The Council should better guide programme development and policy direction on science, technology, innovation and culture as parts of the post-2015 development framework using its expertise, knowledge resources and convening power. As a system, the Council can bring to bear the full knowledge and expertise of the United Nations system on urgent development challenges, linking the possibilities of science, technology, innovation and culture to the discussion. The Council should draw on the expertise of the United Nations system, as well as engage external stakeholders through its networks of experts in the academic and scientific realms, private sector and civil society.

125. As a "thought leader" on economic, social and environmental issues, the Economic and Social Council system, including the Commission on Science and Technology for Development, contributes to the production of a large number of knowledge resources each year. These knowledge resources could better guide international cooperation on science, technology, innovation and culture-related issues. Such knowledge should be shared across the United Nations system in a more integrated way, enabling the Economic and Social Council to identify areas for further work, and conduct analysis to inform high-level policy discussions.

126. In the outcome document of the United Nations Conference on Sustainable Development, "The future we want",[20] world leaders recognized that inter- and

[19] The importance of ensuring that science, technology and innovation resources are inclusive was highlighted at the annual ministerial review regional meeting for Latin America and the Caribbean, held in Lima from 7 to 9 January 2013, in the context of the Commission on Science and Technology for Development intersessional meeting.

[20] General Assembly resolution 66/288.

intra-disciplinary sharing of knowledge is essential to create the individual and organizational capacity necessary for achieving an integrated approach to sustainable development. The Council could consider developing further its system of knowledge-sharing to meet this mandate and enhance its work. This new approach to knowledge-sharing would more efficiently bring together inputs and expertise from all of the various Economic and Social Council partners in order to channel available knowledge on specific sustainable development issues to Governments and other stakeholders in a cohesive manner. It would contribute to building a common knowledge base that contributes to managing and diffusing research findings, scientific advances and the potential for technology transfer.

127. In keeping with its mandate to promote policy coherence, the Economic and Social Council, including through the Commission on Science and Technology for Development, could commit to addressing science, technology, innovation and culture for sustainable development by:

(a) Promoting global policy consensus on the importance of science, technology, innovation and culture as enablers for sustainable development and essential elements of the post-2015 development agenda;

(b) Facilitating collaboration among a broad range of stakeholder groups, including research communities, the private sector and civil society;

(c) Strengthening international cooperation to build capacities in science, technology and innovation for successfully addressing complex development challenges;

(d) Enhancing the science-policy interface within the United Nations development system by leveraging the expertise of the Committee for Development Policy, which could provide inputs and independent advice to the Council on science, technology, innovation and culture as cross-cutting issues;

(e) Analysing, in particular, how those living in poverty could benefit from — and potentially be left behind by — emerging technologies;

(f) Promoting a human-centred approach, tailored to local contexts, which takes into account cultural considerations when designing and implementing sustainable development strategies;

(g) Building a common knowledge base that contributes to managing and diffusing research findings, scientific advances and the potential for technology transfer;

(h) Encouraging the enabling legal, policy and institutional frameworks at the national and regional levels to facilitate the enhancement of indigenous knowledge, research and innovation and the adaptation of appropriate technology;

(i) Working especially with the regional commissions and the United Nations specialized agencies to identify ways to more effectively coordinate collaboration at the regional level, particularly through the annual ministerial review and the Development Cooperation Forum;

(j) Supporting the elaboration of relevant goals, targets and monitoring systems to mainstream science, technology and innovation into development, in the context of the post-2015 framework.